Applicants elected with traverse the species of Figure 1 in response to the restriction requirement mailed on February 14, 2002. In making that election, and in compliance with the requirement to do so, Applicants listed claims 1, 4 to 9, 13, and 28 to 33 as readable on the elected species. However, the examiner withheld from examination, without explanation, claims 5 to 8, 13, and 28 to 32. Applicants note that the Examiner has made the election requirement final and repeat their traversal of the requirement; however, Applicants believe that they are entitled at least to an examination on the merits of claims 5 to 8, 13, and 28 to 32 along with claims 1, 4, 9, and 33, which examination is respectfully requested.

In making the restriction requirement final, the Examiner states that the argument that the features shown in the species of Figure 1 are carried on in any of the configurations shown in Figures 2, 25, 35, 37, 40, and 45 "is not persuasive because Applicants have not admitted on the record that the species are not patentably distinct." The Examiner does not seem to understand the point of the argument. The question is not whether the several species are patentably distinct but whether there is a generic claim. The fact that the structure of Figure 1 is replicated in each of the structures shown in Figures 2, 25, 35, 37, 40, and 45 is graphic indication that claim 1, which reads on Figure 1, also reads on Figures 2, 25, 35, 37, 40, and 45. Note also that there is only one independent claim, claim 1, and that all other claims in the application are either directly or indirectly dependent on claim 1. Claim 1 is a generic claim to all the embodiments (e.g., "species") disclosed.

For the Examiner's benefit, the several drawing figures (i.e., embodiments) are compared. Both Figures 1 and 2 show in generalized form electron beam irradiation means 1 for irradiating a semiconductor device 5 as a sample under test with an electron beam while scanning the semiconductor device. Both Figures 1 and 2 show an ammeter 8 for measuring the current generated in the sample as a result of the irradiation by electron beam, and both Figures 1 and 2 show data processing means 10 for processing measured data from the ammeter, as well as a moving distance measuring device 8 and a beam control portion 11. The only

difference between Figures 1 and 2 is the optics between the electron gun 1 and the sample 5. In the case of Figure 1, the optics comprise a condenser lens 3 and an aperture plate 4, while in Figure 2, the optics comprise a condenser lens 13, an aperture plate 14, a second condenser lens 15 and an objective lens 16. These differences are solely for the purpose of controlling the size of the electron beam which is used to scan the sample.

Figure 25 differs from Figures 1 or 2 in that the details of the data processing means 10 are shown in more detail. Specifically, the data processing means as shown in Figure 25 a D/A converter 120, memories 121 and 122, a waveform comparator 123, a defect detector 124 which accesses a database 125, a defect memory 126, and a defect output position device 127. Figure 35 is similar to Figure 27 except that it substitutes pulse integrators 191 and 192 and integrated value comparator 193 for the waveform comparator 193. Figure 37 is similar to Figure 27 except that it substitutes memory 201, for memories 121 and 122, and substitutes pulse integrator 202, pulse width detector 203, divider 204 and memory 205 for the waveform comparator 193. Figure 40 is a variation of Figure 37, and Figure 45 is a variation of Figure 27.

In summary, a claim such as claim 1 which recites the basic components of electron beam irradiation means 1 for irradiating a semiconductor device 5 as a sample under test with an electron beam while scanning the semiconductor device, a current measuring device (ammeter 8) for measuring the current generated in the sample as a result of the irradiation by electron beam, and data processing means 10 for processing measured data from the current measuring means for obtaining an information related to a structure of the sample in a depth direction on the basis of a difference in transmittivity of the electron beam for the sample when the latter is scanned with different acceleration voltages reads on all the several "species" identified by the Examiner and, therefore, is a generic claim, contrary to the Examiner's position.

In view of the above analysis, it is submitted that the restriction requirement is in error and should be withdrawn. In the alternative, the Examiner

is requested to recognize that there is a generic claim in the application and to examine on the merits all those claims listed as readable on the elected species.

The title of the invention has been changed as required by the Examiner. The new title is believed that the title is clearly indicative of the invention to which the claims are directed.

The drawings were objected to under 37 C.F.R. §1.83(a). The Examiner takes the position that certain elements recited in the claims are not illustrated in the drawings. The Examiner is in error, as demonstrated below, and therefore the objection to the drawings should be withdrawn. No correction to the drawings is necessary.

As to claim 1, the Examiner identifies the "means for obtaining an information related to a structure of a sample" as not shown in the drawings. In context, what claim 1 recites is "said data processing means includes means for obtaining an information related to a structure of the sample in a depth direction on the basis of a difference in transmittivity of electron beam for the sample when the latter is scanned with different acceleration voltages". The data processing means is shown as block 10 in each of Figures 1 and 2 and, as explained above, the data processing means is shown in more detail in each of Figures 25, 35, 37, and 40. As explained in the specification at page 24, lines 11 to 18:

> "Current collected by the electrode is measured by the ammeter 9. The measured current is converted into a digital signal and outputted to the data processor 10. In order to improve the anti-noise characteristics of the tester, it may be effective to construct the ammeter 9 with a differential amplifier.
>
> "*The data processor 10 processes various data and, particularly, can obtain an information related to a structure of a sample under test in a depth direction thereof from a difference of transmittivity of electron beam of the sample when scanned with electron beam at different acceleration voltages*." (Emphasis added.)

As to claim 4, the Examiner identifies the feature of "means for vertically irradiating" as not shown in the drawings. The electron gun 1 shown in each of Figures 1 and 2 and, in particular, the electron gun 112 shown in Figure 25 illustrate this structure. As described beginning on page 51, line 20, and continuing to page 52, line 17, of the specification:

> "In FIG. 25, the apparatus for performing the comparative test includes *an electron gun 112 for producing electron beam vertically irradiating test samples on a wafer 111*, a compensation current measuring electrode 113 on which the wafer 111 is mounted with a bottom surface thereof in contact with an upper surface of the electrode, an XY stage 114 mounting the electrode 113, for determining a positional relation between the wafer 111 on the electrode and electron beam irradiating the wafer, a position detector 115 for precisely measuring the position of the sample irradiated with electron beam, an irradiating position control device 116 for producing a control signal for controlling the irradiating position of electron beam on the basis of a result of detection from the position detector 115, an electron gun control device 117 for controlling the electron gun 112 on the basis of the control signal from the irradiating position control device 116, a stage controller 118 for controlling the XY stage 114 on the basis of the control signal from the irradiating position control device 116, a current amplifier 119 for amplifying compensation current of the electrode 113, a D/A converter 120 for converting an output of the current amplifier 119 into a digital signal, a first and second memories 121 and 122 for storing the digital signal as current waveforms correspondingly to positional coordinates, a waveforin comparator 123 for comparing the stored waveforms, a defect detector 124 for determining the quality of wiring on the basis of a result of the comparison, a database 125 storing an information for

determining the quality, a defect position memory 126 for storing positions which are determined as defective and a defect position output device 127 for displaying and/or printing the defect position or outputting the defect position to other processors on a network. The irradiating position detector 125 may be, for example, an optical precision distance measurement device." (Emphasis added.)

As to claim 9, the Examiner identifies the feature of "means for comparing a current vale [sic] ..." as not shown in the drawings. Again, the data processing means 10 shown in Figures 1 and 2 and shown in more detail in Figures 25, 35, 37, and 40 is the questioned means. As generally described in the specification at page 11, lines 11 to 21:

"The electron beam irradiation means includes means for scanning a sample under test with line shaped electron beam having a length capable of irradiating a plurality of wiring lines of the sample as a lump in a direction perpendicular to a lengthwise direction of the line shaped electron beam and moving the sample in a direction perpendicular to the scanning direction by a width of electron beam irradiating a scan position every time when one line scan is completed and *the comparison means may include means for comparing current waveforms measured as variations of current values for electron beam irradiating positions in the two regions*. In this case, the means for comparing waveforms may include means for integrating the waveforms and comparing the integrated values." (Emphasis added.)

Figure 25 shows a waveform comparator 123 as part of the data processing means 10, and Figure 35 shows an integrated value comparator 193 as part of the data processing means 10.

As to claim 33, the Examiner identifies the feature of "means for correcting current component flowing through a capacitance..." as not shown in

the drawings. In context, claim 33 recites "said data processing means includes means for correcting current component flowing through a capacitance of a sample under test..." In other words, the means questioned by the Examiner is part of the data processing means 10 shown in Figures 1 and 2. It is assumed that the Examiner understands that a data processor is a device which is programmed to perform a number of functions. As described beginning on page 75, line 27, and continuing to page 76, line 17:

> "In the described tests, current produced in a substrate by scanning a sample surface with electron beam is recorded as a function of electron beam scanning position and, by utilizing the function as a luminance signal for image display, a current image is formed on the substrate surface. Further, when the image is used in a contact-hole test, the magnitude of current flowing in the contact-hole in a D.C. sense becomes a reference for determining the quality of the contact-hole. However, an A.C. component is produced since it is practical that pulsed electron beam irradiates the surface periodically or the surface is scanned by electron beam. Therefore, a measured current contains a cap acitive A.C. component in addition to the D.C. component. With such A.C. component, the correspondence between brightness of image and a physical object is broken, so that the quality determination of contact-hole becomes inaccurate and the restoration of three-dimensional configuration of the contact-hole becomes difficult.
>
> "In order to solve such problem, it is preferable to measure a current by changing an irradiation frequency or scanning frequency of electron beam to thereby correct the current component flowing through a capacitance of the sample under test. *The processing flowcharts for performing such correction are shown in FIGs. 69 and 70, respectively.*" (Emphasis added.)

It is believed that the foregoing explanation clearly establishes that the drawings fully meet the requirements of 37 C.F.R. §1.83(a). The objection to the drawings should therefore be withdrawn.

Claims 1, 4, 9, and 33 were rejected under 35 U.S.C. §112, second paragraph, as being indefinite. The claims have been amended as appropriate and, as amended, are believed to be clear and definite.

As to claim 1, the Examiner says that it is unclear what "means for obtaining an information related to a structure of the sample..." represents and asks whether it is shown in any of the drawings. This appears to be a repetition of the Examiner's earlier objection to the drawings and has been fully responded to in the foregoing discussion. The Examiner also makes the observation that "said current measuring means" has no antecedent basis. Claim 1 has been amended to correct the lack of antecedent basis.

As to claim 4, the Examiner says that it is unclear what "means for vertically irradiating..." represents and asks if it is shown in the elected species of Figure 1. As explained above in response to the objection to the drawings, the electron gun 1 shown in Figure 1 is the questioned means. Claim 4 has been amended to correct minor grammatical errors.

As to claim 9, the Examiner says that it is unclear what "means for comparing a current vale [sic]..." represents and again asks if it is shown in the elected species. Once again, as explained in the response to the objection to the drawings, the questioned means is the data processor 10. Claim 9 has been amended to correct a minor typographical error and a minor grammatical error.

Finally, as to claim 33, the Examiner says that it is unclear what "means for correcting current component flowing through a capacitance..." represents and asks whether it is shown in the elected species of Figure 1. And once again, as explained in the response to the objection to the drawings, the questioned means is the data processor 10.

It is respectfully submitted that the claims are in fact clear and definite and fully supported by the specification and drawings. Withdrawal of the rejection

under 35 U.S.C. §112, second paragraph, is requested.

Claim 1 was additionally rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 4,980,639 to Yoshizawa et al. This rejection is respectfully traversed for the reason that Yoshizawa et al. neither shows nor suggests the claimed invention.

The disclosed and claimed invention is directed to a semiconductor device tester in which current flowing through a semiconductor device irradiated with an electron beam is measured. The semiconductor device tester according to the present invention includes electron beam irradiation means 1 for irradiating a semiconductor device 5 as a sample under test with electron beam while scanning the semiconductor device, current measuring means 9 for measuring current produced in the sample by irradiation of electron beam and data processing means 10 for processing measured data from the current measuring means. The electron beam irradiation means includes collimator means for collimating the electron beam to parallel beam and means for changing acceleration voltage of electron beam. The data processing means includes means for obtaining an information related to a structure of the sample in a depth direction on the basis of a difference in transmittivity of electron beam for the sample when the latter is scanned with different acceleration voltages.

The present invention can be utilized in combination with a Scanning Electron Microscope (SEM). That is, the semiconductor device tester according to the present invention further comprises a secondary electron detector for detecting secondary electron emitted from a surface of a sample under test, wherein the data processing means may include correspondence means for making an amount of secondary electron measured by the secondary electron detector correspondent with the result of measurement of the current measuring means. The sample under test can be vertically irradiated along the line segment passing through a center of a measuring region with an electron beam having spot size smaller than an area of the measuring region by means of the electron beam irradiating means, obtaining a bottom distance of the measuring region from a distance between a rising and

falling edges of current measured along the line segment by means of the current measuring means and obtaining an upper distance of the measuring region from a distance between a rising and falling edges of the secondary electron detected by the secondary electron detector. The correspondence means may include means for three-dimensionally displaying a circular pillar or a frustum of a cone having the measured bottom distance, upper distance and film thickness of the measuring region as a bottom diameter, an upper diameter and a height.

Since it is possible to measure in an analog manner an area and diameter of a bottom of a contact-hole or a three-dimensional configuration thereof at high speed during a process, it is possible to improve the process in that state. For example, in order to provide the etching condition, it is necessary to control both the opening configuration and the bottom configuration of the contact-hole. When the present invention is used, it is possible to measure a distribution of bottom areas of contact holes of a wafer then and there.

Yoshizawa et al. disclose a method and apparatus for testing electrical characteristics of an integrated electronic device, such as leakage current and capacitance. While Yoshizawa et al. use an electron beam irradiation means and a current measuring means, as does the claimed invention, they do not generate or process the same data as do the Applicants. In Applicants' invention, the acceleration voltage of the electron beam is changed and the data generated by this operation is processed by the data processing means to obtain "information on the structure of the sample in a depth direction on the basis of the transmittivity of the electron beam for the sample when the latter is scanned with different acceleration voltages." (Emphasis added). In other words, what Applicants have accomplished with their invention is obtaining information related the structure of the sample in the depth direction. As clearly stated on page 1, lines 20 and 21, of the specification, "In order to optimize etching condition, it is necessary to detect an outer and inner configurations of a contact-hole or a state of a bottom of the contact-hole." This is what the claimed invention does.

The superficial similarity of Yoshizawa et al. to the structure shown in the

several embodiments of the disclosed invention is due to the fact that Scanning Electron Microscope (SEM) technology is used; however, Yoshizawa et al. were not the first to use SEM technology to measure integrated circuit characteristics. What is important to understand is what is being measured and how that characteristic is measured. In the present case, Yoshizawa et al. do not measure what Applicants measure and Applicants perform their measurement in a manner different than how Yoshizawa et al. perform their measurement.

While the Examiner has cited two other U.S. patents as being pertinent to Applicants' disclosure, neither of these is relevant to the disclosed and claimed invention for obtaining information related the structure of the sample in the depth direction.

None of the other claims considered by the Examiner were rejected on the prior art, and since all of the claims, both those considered by the Examiner and those withdrawn from consideration, are dependent on claim 1 and claim 1 is clearly patentable over the prior art, all of claims 1 to 35 are patentable.

In view of the foregoing, it is respectfully requested that the application be reconsidered, that claims 1 to 35 be allowed, and that the application be passed to issue.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

A provisional petition is hereby made for any extension of time necessary for the continued pendency during the life of this application. Please charge any fees for such provisional petition and any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 50-2041.

Respectfully submitted,

C. Lamont Whitham
Reg. No. 22,424

30743
PATENT TRADEMARK OFFICE

Clean Copy of Amended Paragraphs

Paragraph beginning on page 1, line 22, and continuing to page 2, line 10, now reads as follows:

Since the diameter of contact-hole is in the order of microns or less, visible light can not illuminate the bottom of the contact-hole, so that it is difficult, to detect the state of the contact-hole optically. Therefore, SEM (Scanning Electron Microscope) suitable for analysis of a fine structure has been mainly used as a tester. In the SEM, a contact-hole region is irradiated with electron beam, which is accelerated to several tens keV and collimated to several nanometers, and secondary electron produced in the irradiated region is detected by a secondary electron detector, on which an image of the contact hole is formed. A specimen irradiated with the electron beam generates secondary electrons, an amount of which corresponds to constituting atoms thereof. However, the secondary electron detector in the SEM is usually arranged in a specific direction, so that a whole of produced secondary electrons are not always detected. If the specimen includes irregularity in its structure, there is a case where secondary electron is not detected depending upon portions of the specimen, resulting in that contrast is produced in an image of the specimen under test, which is formed of a single substance. This is the feature of the SEM.

A2

Paragraph on page 5, lines 6 to 20, now reads as follows:

Further, it is possible to know a film thickness by measuring a substrate current. For example, JP P62-19707A discloses a technique in which a relation between a waveform of a substrate current, acceleration voltage of electron beam and a film thickness, when a pulsed electron beam irradiation is performed, is preliminarily obtained and a film thickness is obtained from a current waveform. measured by using electron beam accelerated with a certain acceleration voltage. Further, JP P2000-124276A discloses a technique in which a current, which is not

A3

A3 Cont

a variation of current with time but a current value, produced by irradiating a test sample with electron beam and passed through the test sample to a backside surface thereof is measured. In a technique disclosed in JP 2000-180143A, a current flowing through a thin film to a substrate, is measured and a film thickness is obtained by comparing the measured current with a current value obtained for a standard sample and JP P2000-164715A discloses a standard sample suitable for use in the technique disclosed in JP P2000-180143A.

Paragraph on page 6, lines 12 to 17, now reads as follows:

A4

The reason for the use of parallel electron beam in the present invention is that, when a converging electron beam is used, it is necessary to condense the electron beam to a vertical level of a measuring location and, so, it is not suitable in obtaining an information of the sample in a depth direction thereof. When a parallel electron beam is used, focal distance becomes infinite so that focus regulation becomes unnecessary.

Paragraph on page 7, lines 1 to 8, now reads as follows:

A5

The electron beam irradiation means includes an electron gun and the collimator means includes a condenser lens for collimating the electron beam emitted from the electron gun to <u>a</u> parallel beam and an aperture plate having an aperture inserted between the condenser lens and the semiconductor device, for limiting a spot size of electron beam such that electron beam impinges an opening portion. The electron beam irradiation means preferably includes means for moving the sample under test with respect to electron beam in order to scan-the ample with electron beam.

Paragraph on page 12, lines 21 to 26, now reads as follows:

A6

The means for obtaining information related to the structure in the depth direction preferably includes means for obtaining a three-dimensional configuration of a through-hole provided in an insulating film by measuring values

A6 cont

of current produced by irradiation of electron beam passing through a portion of the insulating film, which surrounds the through-hole, with increased acceleration voltage.

Paragraph on page 24, lines 7 to 10, now reads as follows:

A7

Since size of the contact-hole to be measured is very small, the sample 5 should be put on the stage 6 flat. In order to realize such arrangement of the sample 5 on the stage 6, it may be effective to press an outer periphery of the sample 5 onto the stage 6 by using such as ring-shaped jig.

Paragraph on page 24, lines 19 to 25, now reads as follows:

A8

FIG. 2 is a block diagram of a semiconductor device tester according to a second embodiment of the present invention, which is suitable when a cross sectional area of electron beam is on the order of a micron. In this tester, an electron beam generation system includes an afocal system composed of a second condenser lens 15 and an objective lens 16 and constitutes an electron optics system for converting incident parallel beam into parallel beam having cross sectional area smaller than an aperture area of an aperture plate 14.

Paragraph beginning on page 26, line 18, and continuing to page 27, line 6, now reads as follows:

A9

FIG's. 6(a) and 6(b) illustrate the measuring method, in which FIG. 6(a) shows a structure of a contact-hole 43 to be measured and a measuring system therefor and FIG. 6(b) shows an example of a result of measurement. The contact-hole 43 is formed such that it penetrates an [m] insulating film 41 formed on an underlying substrate 42. The insulating film 41 may be an oxide film or a nitride film, etc. In a good, that is, normal contact-hole, a surface of the underlying substrate 42 or a surface of a wiring layer formed below the insulating film is exposed. Electron beam 31 having a diameter in the order of 100Å and generated by the tester shown in FIG. 1 or FIG. 2 is vertically directed to a sample having the

A9 Cont

contact-hole 43 formed therein while scanning it horizontally. Acceleration voltage and current of electron beam 31 are set to in a range from 0.5kV to several kV and several nA, respectively. When electron beam 31 passes through the contact-hole 43 down to the underlying substrate 42, current flows through the underlying substrate 42. The current is referred to as "compensation current". FIG. 6(b) shows compensation current produced when the sample is scanned by electron beam in a horizontal direction along a center line of the contact-hole 43.

Paragraph beginning on page 29, line 19, and continuing to page 30, line 7, now reads as follows:

A10

FIG's. 10(a) and 10(b) illustrate a measurement of a contact-hole by using electron beam of which cross sectional area is larger than the aperture of the hole, in which FIG. 10(a) shows a structure of a contact-hole to be measured and a measuring system therefor and FIG. 10(b) shows an example of a result of measurement. FIG's. 11(a) and 11(b) illustrate a measurement of a tapered contact-hole by using electron beam of which cross section area is larger than the aperture of the hole, in which FIG. 11(a) shows a structure of the contact-hole to be measured and a measuring system and FIG. 11(b) shows an example of a result of measurement. In each of the measurements, the electron beam generator shown in FIG. 1 or FIG. 2 is used and a cross sectional area of the electron beam is set to a value (for example, several microns square) larger enough than an area of the contact-hole. Compensation current is measured under condition that a sample is vertically irradiated with electron beam such that a whole bottom of the contact-hole thereof is irradiated simultaneously with the electron beam. An electron beam source is preferably capable of emitting electron beam whose intensity distribution within a cross sectional beam area is as flat as 1% or less.

[Paragraph on page 30, lines 8 to 17, now reads as follows:]

When a whole contact-hole 43 or 44 is irradiated with electron beam 51 at once, compensation current produced in an exposed portion of an underlying

substrate 42 is measured by an ammeter 9 at once. Since the secondary electron emitting efficiency is specific to substance to be irradiated with electron beam, an amount of compensation current in unit area of the region in which the underlying layer is exposed is constant throughout the region if electron beam irradiation condition is the same. Therefore, when the whole bottom of the contact-hole 43 or 44 is irradiated with electron beam 51, compensation current, which is proportional to the bottom area of the contact-hole 43 or 44, is observed as shown in FIG. 10(b) or FIG. 11(b).

A10 Cont

Paragraph on page 33, lines 12 to 25, now reads as follows:

A method for determining compensation current per unit area when the standard sample having a contact-hole whose bottom area is known can not be prepared will be described with reference to FIG's. 12(a) and, 12(b). In the method, electron beam 52, which is sufficiently thinner than an opening area of a contact-hole of a sample and has a known spot size, is vertically directed into the contact-hole. Since the spot size of electron beam produced by the tester shown in FIG. 1 or FIG. 2 is restricted by size of the aperture forming in the aperture plate, it is possible to obtain the size of the electron beam by calculation. In order to further improve the accuracy of measurement, the diameter of electron beam is directly obtained by the knife edge method, etc. When such electron beam is directed to a standard contact-hole, compensation current such as shown in FIG. 12(b) is measured. A compensation current per unit area of the standard contact-hole is obtained by dividing the thus obtained compensation current by the spot size of electron beam.

A11

Paragraph on page 36, lines 15 to 24, now reads as follows:

When the information is displayed on the image display device with using the compensation current value or the diameter of the opening portion of the contact-hole as a reference, there may be a case where luminance is too high or too low, causing an image on a screen to be hardly looked. Therefore, it is necessary

A12

A12 (cont)

to correct the image display to thereby make the displayed image easily visible. As a correction method of the image display, a regulation of luminance on the basis of a center value may be considered, for example. Further, since defective products is more important than good products in fabrication process, it is preferable to make an information of defective product easier to see.

Paragraph on page 40, lines 4 to 11, now reads as follows:

A13

As electron beam scanning a periphery of the contact-hole and an interior thereof, the parallel electron beam obtained by the tester shown in FIG. 1 or FIG. 2 is utilized. When a converging electron beam is used, it is necessary to regulate a focus of the beam to a vertical position which is different between a case where the periphery of the contact-hole is scanned and a case where the bottom of the contact-hole is scanned. However, when the parallel electron beam is used, the focal length becomes infinite and, therefore, there is no need of focus regulation.

Paragraph on page 42, lines 5 to 15, now reads as follows:

A14

FIG's. 16(a) and 16(b), 17(a) and 17(b) and 18(a), 18(b) and 18(c) illustrate examples of measurement of a cylindrical contact-hole, a tapered contact-hole and a reverse-tapered contact-hole, respectively, in which FIG's. 16(a), 17(a) and 18(a) shows structure of the respective contact-holes and measuring systems therefor, FIG's. 16(a), 17(b) and 18(b) show amounts of secondary electron (upper lines) and amounts of measured compensation current (lower lines) with respect to positions irradiated with electron beam. Deviations between measuring points of secondary electron and compensation current caused by the slanted incident beam are corrected to the positions of the contact-holes. FIG. 18(c) shows a three-dimensional configuration of a restored reverse-tapered contact-hole.

Paragraph beginning on page 45, line 28, and continuing to page 46, line13, now reads as follows:

FIG's. 20(a) and 20(b) show an example when dust 72 is deposited on a bottom of a tapered contact-hole 44. When the scanning of the sample with vertical thin electron beam 31 is started from a left side position in FIG. 20(a), compensation current is not observed during a time for which electron beam 31 irradiates an insulating film 41 surrounding the contact-hole 44. When electron beam 31 irradiates the tapered portion, no compensation is detected since the thickness of the insulating film is large. On the other hand, when electron beam 31 reaches an edge of the contact-hole 44, compensation current is detected. Although a constant compensation current is detected for a time for which electron beam 31 irradiates a bottom of the contact-hole 44, no compensation current is observed when electron beam 31 irradiates the dust 72. Existence or absence of dust or size of dust can be obtained by comparing the result of measurement with a result of measurement performed for a contact-hole having no dust.

A15

Paragraph on page 46, lines 14 to 26, now reads as follows:

FIG's. 21(a) and 21(b) show an example when dust 73 exists on a center portion of a bottom of a reverse-tapered contact-hole 45. When the scanning of the sample with electron beam 31 is started, compensation current is not observed during a time for which electron beam 31 irradiates an insulating film 41 surrounding the contact-hole 45. When electron beam 31 reaches the bottom of the contact-hole 45 large compensation current is detected. When electron beam 31 reaches the dust 73, no compensation current is detected. When electron beam 31 passes over the dust 73 and irradiates the bottom of the contact-hole 45, compensation current is detected again. When electron beam 31 reaches an edge of the contact-hole 45, no compensation current is detected. The position of the sample, at which no compensation current is detected, corresponds to a region in which the dust 73 exists and the size of the dust 73 can be estimated from a width of this region.

Paragraph on page 47, lines 12 to 17, now reads as follows:

A16

FIG's. 22(a), 22(b) and 22(c) illustrate an example of measurement utilizing electron beam having a large cross sectional area, in which FIG. 22(a) is a plan view showing a relation between a contact-hole 81 and electron beam 82, FIG. 22(b) is a cross section thereof and FIG. 22(c) shows compensation current obtained with respective to compensation current obtained with respect to the scanning position of electron beam and a differentiation thereof.

Paragraph beginning on page 54, line 23, and continuing to page 55, line 3, now reads as follows:

A17

The chips used in FIG's. 29(a) and 29(b) have the nature described with reference to FIG's. 27 and 28 and are arbitrarily selected from a plurality of chips simultaneously formed on a semiconductor wafer. The chips to be compared with each other depend upon a case. However, it is general that the chips are adjacent ones or that the test is performed by selecting a specific chip, which may be a normal chip, as the first sample, with sequentially changing other chips as the second sample. It may be possible to compare test results of three chips or more and determine a chip or chips, whose test results indicate many coincidences with those of the specific chip, as normal chips.

Clean Copy of Amended Claims

Sub. B1

1. A semiconductor device tester comprising: electron beam irradiation means for irradiating a semiconductor device as a sample under test with an electron beam while scanning the semiconductor device;

A18

a current measuring means for measuring current flowing through the semiconductor resulting from irradiation by the electron beam; and

data processing means for processing measured data from said current measuring means,

wherein said electron beam irradiation means includes collimator means for collimating the electron beam to a parallel beam and means for changing an acceleration voltage of the electron beam and wherein said data processing means includes means for obtaining an information related to a structure of the sample in a depth direction on the basis of a difference in transmittivity of the electron beam for the sample when the latter is scanned with different acceleration voltages.

A19

4. A semiconductor device tester as claimed in claim 1, wherein said electron beam irradiating means includes means for vertically irradiating said sample along a line segment passing through a center of a measuring region of said sample with an electron beam having spot size smaller than an area of said measuring region and said data processing means includes means for obtaining a distance of a bottom of said measuring region from a space between rising and following edges of a current measured along said line segment.

A20

9. A semiconductor device tester as claimed in claim 1, wherein said data processing means includes means for comparing a current value measured correspondingly to a positional coordinates when a wafer under test is

A20 cont

irradiated with an electron beam with a current value to be measured at the same positional coordinates of the wafer is good and setting the kind of process to be performed next on the basis of the result of the comparison.